

ON A LATENT STRUCTURE OF LEPTON UNIVERSALITY

Rasulkhodzha S. Sharafiddinov

Institute of Nuclear Physics, Uzbekistan Academy of Sciences,
Tashkent, 702132 Ulugbek, Uzbekistan

The mass of an electroweakly charged lepton consists of the two components of the electric and weak nature and regardless of the difference in masses, all leptons have an equal charge with his radius as well as an identical magnetic moment. Between these currents there appear the most diverse connections, for example, at their interactions with an electroweak field of spinless nuclei. We derive the united equations which relate the mass and its structural parts to charge, charge radius and magnetic moment of each lepton as a consequence of the ideas of flavor symmetry laws. Thereby, they require the verification of lepton universality from the point of view of a constancy of the size implied from the multiplication of a weak mass of lepton by its all the rest mass. Such a principle gives the possibility to define the lepton weak masses. If this picture is not changed, leptons universally interact not only with photon or weak neutral boson but also with any of gauge fields.

It is indisputable that naturally united regularities of the nature of elementary particles establish a flavor independent symmetry between the interactions of all leptons with each of gauge bosons. However, over fifty years ago when the hypothesis of lepton universality [1, 2] was for the first time formulated and now when a large number of works [3, 4] is dedicated to its different aspects [5, 6], the question as to what is the unified theoretical description of this highly astounding symmetry of the micro-world steel has no unequivocal answer. An exact violation of lepton universality [7] is not observed experimentally [8] and remains the impression that nature itself testifies in favor of such a symmetrical structure. Therefore, to elucidate a truly character of the identical interactions of leptons, it is desirable not only to use the difference in their masses as a stimulus to deciding the problem at the new level but also to raise the question as to whether there exists any mass type dependence of lepton universality, and if so what the expected connection says about the mechanism of the discussed universal phenomena.

Many authors state that no any rest mass dependence of a particle fundamental interactions and fields. Its existence would seem contradicts our observation that electron, muon and tau lepton which possess the same charge and an equal magnetic moment, have the difference masses.

It is interesting, however, that the same charge of a Coulomb nature may not be both an electric and a weak charge. At the same time, each of the existing types of leptons can interact with all gauge bosons.

The basis for our approach is that in the framework of classical theory of an extensive electron [9], a particle mass has purely electromagnetic nature. If take this idea, the difference in fermion masses would lead us to the implication that muon and tau lepton possess those interactions which are absent in electron [10]. But a question about their reality thus far remains open.

On the other hand, as known, a steadiness of the electric charge distribution in lepton can be explained by the intralepton interratio of forces of a different nature. According to our description [11], this implies that to any type of charge corresponds a kind of mass. Such a principle reflects the characteristic features of a latent connection between the mass of a particle and its united field of emission.

At the same time, it is clear that each Dirac particle of a Coulomb nature must have the electric [9] as well as the weak [12] mass. In other words, all

the mass m_l and charge e_l of an electroweakly charged lepton ($l = e, \mu, \tau, \dots$) are equal to its electroweak (EW) mass and charge

$$m_l = m_l^{EW} = m_l^E + m_l^W, \quad (1)$$

$$e_l = e_l^{EW} = e_l^E + e_l^W \quad (2)$$

consisting of the electric (E) and weak (W) parts. They have the crucial value for the photon and weak neutral leptonic currents.

In conformity with the ideas of the quantum electrodynamics, the first of these currents include the following interaction [10, 13] terms:

$$j_\mu^\gamma = \bar{u}(p', s') [\gamma_\mu F_{1l}(q^2) - i\sigma_{\mu\lambda} q_\lambda F_{2l}(q^2)] u(p, s), \quad (3)$$

where $\sigma_{\mu\lambda} = [\gamma_\mu, \gamma_\lambda]/2$, $p(s)$ and $p'(s')$ denote the four-momentum (helicities) of incoming and outgoing fermions, $q = p - p'$, the form factors $F_{il}(q^2)$ constitute the current Dirac ($i = 1$) and Pauli ($i = 2$) vector V_l components. Here we present their in the form [14]

$$F_{il}(q^2) = f_{il}(0) + R_{il}(\vec{q}^2) + \dots \quad (4)$$

The values of $f_{il}(0)$ define the static size of lepton electric charge and magnetic moment. The terms $R_{il}(\vec{q}^2)$ characterize the three-dimensional momentum transfer dependence of form factors.

Of them $R_{1l}(\vec{q}^2)$ describe the interaction between charge r_l radius of lepton and field of emission of photon: $R_{1l}(\vec{q}^2) = -(\vec{q}^2/6) < r_l^2 > .$

It is clear, however, that each type charge of any lepton constitutes a kind of leptonic current. According to the standard electroweak theory [15], the latter implies that the terms F_{1l} and F_{2l} describing the Coulomb scattering of leptons do not coincide with the corresponding size from those form factors which arise at their interactions with the united field of emission of photon and weak neutral boson [16].

A given circumstance may serve as a certain indication to an explicit mass structure dependence of lepton universality. To decide this question one must apply to the processes on target nuclei, because they can shed light on nature of the identical lepton interactions.

Our present work is dedicated to the definition of a latent structure of the universal interactions of leptons with the Coulomb, weak and the electroweakly united fields of emission and of a role in their formulation of

the structural components of an electroweak mass. For this we investigate here the behavior of all types of leptons in the elastic scattering on a spinless nucleus as a consequence of the availability of the Coulomb m_l^E , weak m_l^W and the united electroweak m_l^{EW} rest masses and of the electric $f_{1l}(0)$ charge, charge r_l radius and magnetic $f_{2l}(0)$ moment of longitudinal polarized fermions with the vector neutral V_l currents.

Insofar as the axial-vector A_l currents are concerned, we will start from the requirement [17] that the same particle possesses simultaneously only one of the currents, V_l or A_l but not of each of them. Our reasoning refer to those leptons, among which no fermions with A_l currents.

The scattering of leptons by nuclei in the limit of one-boson exchange can therefore be described by the matrix elements [16]:

$$M_{fi}^E = \frac{4\pi\alpha}{q_E^2} \bar{u}(p'_E, s') \{ \gamma_\mu [f_{1l}^E(0) + \frac{1}{6} q_E^2 < r_l^2 >_E] - i\sigma_{\mu\lambda} q_E^\lambda f_{2l}^E(0) \} u(p_E, s) < f | J_\mu^\gamma(q_E) | i >, \quad (5)$$

$$M_{fi}^W = \frac{G_F}{\sqrt{2}} \bar{u}(p'_W, s') \gamma_\mu g_{V_l} u(p_W, s) < f | J_\mu^{Z^0}(q_W) | i >. \quad (6)$$

Here $l = l_{L,R}^-(l_{R,L}^+)$, $q_E = p_E - p'_E$, $q_W = p_W - p'_W$, $p_E(p_W)$ and $p'_E(p'_W)$ imply the four-momentum of a particle before and after the Coulomb (weak) interaction, the functions f_{il}^E and $< r_l^2 >_E$ describe a latent electric m_l^E mass dependence of lepton charge, charge radius and magnetic moment, J_μ^γ and $J_\mu^{Z^0}$ characterize the nuclear currents in the processes with photon and Z^0 -boson, g_{V_l} denotes the weak neutral leptonic current vector part constant.

We have already mentioned that any type lepton can have simultaneously both Coulomb and weak masses [9, 12]. Therefore, from the point of view of each of the scattering amplitude (5) or (6), it should be added [16] that to the process going at the expense of an electroweak interference answers the naturally united interaction

$$\begin{aligned} Re M_{fi}^E M_{fi}^{*W} = & \frac{8\pi\alpha G_F}{\sqrt{2} q_{EW}^2} Re \Lambda_{EW} \Lambda'_{EW} \{ \gamma_\mu [f_{1l}^I(0) + \\ & + \frac{1}{6} q_{EW}^2 < r_l^2 >_I] - \\ & - i\sigma_{\mu\lambda} q_{EW}^\lambda f_{2l}^I(0) \} \gamma_\mu g_{V_l} J_\mu^\gamma(q_{EW}) J_\mu^{Z^0}(q_{EW}). \end{aligned} \quad (7)$$

The appearance of f_{il}^I and $\langle r_l^2 \rangle_I$ in it is explained by the availability of compound structure of mass and charge. Here we have also used the size

$$\begin{aligned} q_{EW} &= p_{EW} - p'_{EW}, \\ \Lambda_{EW} &= u(p_{EW}, s) \bar{u}(p_{EW}, s), \\ \Lambda'_{EW} &= u(p'_{EW}, s') \bar{u}(p'_{EW}, s'). \end{aligned}$$

In the case of nuclei with the electric Z and weak Z_W charges and of longitudinal polarization of leptons, the differential cross section of the studied process on the basis of (5)-(7) and the standard definition

$$\frac{d\sigma_{E,W}(s, s')}{d\Omega} = \frac{1}{16\pi^2} |M_{fi}^E + M_{fi}^W|^2 \quad (8)$$

can be presented by following manner:

$$\begin{aligned} d\sigma_{E,W}^{V_l}(\theta_{E,W}, s, s') &= d\sigma_E^{V_l}(\theta_E, s, s') + \\ &+ d\sigma_I^{V_l}(\theta_{EW}, s, s') + d\sigma_W^{V_l}(\theta_W, s, s'), \end{aligned} \quad (9)$$

where the first term corresponds to the Coulomb scattering and has the form

$$\begin{aligned} \frac{d\sigma_E^{V_l}(\theta_E, s, s')}{d\Omega} &= \frac{1}{2} \sigma_o^E (1 - \eta_E^2)^{-1} \{ (1 + ss') [f_{1l}^E - \\ &- \frac{2}{3} \langle r_l^2 \rangle_E (m_l^E)^2 \gamma_E^{-1}]^2 + \\ &+ \eta_E^2 (1 - ss') [(f_{1l}^E - \frac{2}{3} \langle r_l^2 \rangle_E (m_l^E)^2 \gamma_E^{-1})^2 + \\ &+ 4(m_l^E)^2 (1 - \eta_E^{-2})^2 (f_{2l}^E)^2] t g^2 \frac{\theta_E}{2} \} F_E^2(q_E^2). \end{aligned} \quad (10)$$

The interference cross section explained by the electroweakly united interaction (7) is equal to

$$\begin{aligned} \frac{d\sigma_I^{V_l}(\theta_{EW}, s, s')}{d\Omega} &= \frac{1}{2} \rho_{EW} \sigma_o^{EW} (1 - \eta_{EW}^2)^{-1} g_{V_l} \{ (1 + ss') [f_{1l}^I - \\ &- \frac{2}{3} \langle r_l^2 \rangle_I (m_l^{EW})^2 \gamma_{EW}^{-1}] + \eta_{EW}^2 (1 - ss') [f_{1l}^I - \\ &- \frac{2}{3} \langle r_l^2 \rangle_I (m_l^{EW})^2 \gamma_{EW}^{-1}] t g^2 \frac{\theta_{EW}}{2} \} F_I(q_{EW}^2). \end{aligned} \quad (11)$$

The purely weak contributions are written as

$$\begin{aligned} \frac{d\sigma_W^{V_l}(\theta_W, s, s')}{d\Omega} &= \frac{G_F^2(m_l^W)^2}{16\pi^2} g_{V_l}^2 \{ \eta_W^{-2} (1 + ss') \cos^2 \frac{\theta_W}{2} + \\ &+ (1 - ss') \sin^2 \frac{\theta_W}{2} \} F_W^2(q_W^2). \end{aligned} \quad (12)$$

Here and further we must keep in mind that

$$\begin{aligned} \sigma_o^E &= \frac{\alpha^2}{4(m_l^E)^2} \frac{\gamma_E^2}{\alpha_E}, \quad \rho_{EW} = -\frac{2G_F(m_l^{EW})^2}{\pi\sqrt{2}\alpha} \gamma_{EW}^{-1}, \\ \sigma_o^{EW} &= \frac{\alpha^2}{4(m_l^{EW})^2} \frac{\gamma_{EW}^2}{\alpha_{EW}}, \quad \alpha_K = \frac{\eta_K^2}{(1 - \eta_K^2) \cos^2(\theta_K/2)}, \\ \gamma_K &= \frac{\eta_K^2}{(1 - \eta_K^2) \sin^2(\theta_K/2)}, \quad \eta_K = \frac{m_l^K}{E_l^K}, \\ F_E(q_E^2) &= Z F_c(q_E^2), \quad F_I(q_{EW}^2) = Z Z_W F_c^2(q_{EW}^2), \\ F_W(q_W^2) &= Z_W F_c(q_W^2), \quad q_K^2 = -4(m_l^K)^2 \gamma_K^{-1}, \\ Z_W &= \frac{1}{2} \{ \beta_V^{(0)} (Z + N) + \beta_V^{(1)} (Z - N) \}, \\ A &= Z + N, \quad M_T = \frac{1}{2} (Z - N), \\ \beta_V^{(0)} &= -2 \sin^2 \theta_W, \quad \beta_V^{(1)} = \frac{1}{2} - 2 \sin^2 \theta_W, \\ g_{V_l} &= -\frac{1}{2} + 2 \sin^2 \theta_W, \quad K = E, EW, W. \end{aligned}$$

Among them θ_K are the scattering angles in the Coulomb, electroweak and purely weak processes at the corresponding energies of leptons E_l^K , the functions $F_c(q_K^2)$ are the charge ($F_c(0) = 1$) form factors of a nucleus in these three types of interactions, M_T is the projection of its isospin T , $\beta_V^{(0)}$ and $\beta_V^{(1)}$ are the isoscalar and isovector constants of the nuclear vector neutral current.

The formula (10) contains the purely self interference contributions $(f_{il}^E)^2$ and $\langle r_l^4 \rangle_E$ as well as the contribution $f_{1l}^E \langle r_l^2 \rangle_E$ of the mixed interference between the interactions of lepton charge and charge radius with photon. Any of these components of Coulomb scattering cross section answers to the

formation of one of the left-right and the right-left [18] or of the left - and right-handed [19] dileptons of the vector currents:

$$(l_L^-, l_L^+), \quad (l_R^-, l_R^+), \quad (13)$$

$$(l_L^-, l_R^+), \quad (l_R^-, l_L^+). \quad (14)$$

At the availability of the interaction (7), each of such parafermions must lead to the appearance in the scattering cross section (11) of one of its structural parts $g_{V_l} f_{1l}^I$ or $g_{V_l} < r_l^2 >_I$ and that, consequently, the behavior of dileptons in the nuclear charge field depends on the nature of their lepton interactions. Therefore, from the point of view of (12) and its self interference contributions $g_{V_l}^2$, it should be expected that the possibility of the existence of parafermions of the weak neutral currents is not excluded.

Turning to (8), we remark that it doubles the size of mixedly interference cross sections. However, according to the considerations of symmetry, the number of dileptons and the structural phenomena in which they appear coincide. Of course, this conformity requires the separation of any type of the mixedly interference contribution into the two.

Furthermore, if it turns out that the terms $(1 + ss')$ and $(1 - ss')$ in each of (10)-(12) implies the existence in left ($s = -1$) - and right ($s = +1$)-handed leptons of the vector nature of those types of interactions which are responsible for the scattering with ($s' = s$) or without ($s' = -s$) flip of their helicities, taking into account of the latter, one can replace (9) for

$$\begin{aligned} d\sigma_{E,W}^{V_l}(\theta_{E,W}, s) &= d\sigma_E^{V_l}(\theta_E, s) + \frac{1}{2}d\sigma_I^{V_l}(\theta_{EW}, s) + \\ &+ \frac{1}{2}d\sigma_I^{V_l}(\theta_{EW}, s) + d\sigma_W^{V_l}(\theta_W, s), \end{aligned} \quad (15)$$

where to purely Coulomb scattering corresponds the cross section

$$\begin{aligned} d\sigma_E^{V_l}(\theta_E, s) &= d\sigma_E^{V_l}(\theta_E, f_{1l}^E, s) + \frac{1}{2}d\sigma_E^{V_l}(\theta_E, f_{1l}^E, < r_l^2 >_E, s) + \\ &+ \frac{1}{2}d\sigma_E^{V_l}(\theta_E, f_{1l}^E, < r_l^2 >_E, s) + \\ &+ d\sigma_E^{V_l}(\theta_E, < r_l^2 >_E, s) + d\sigma_E^{V_l}(\theta_E, f_{2l}^E, s), \end{aligned} \quad (16)$$

$$\begin{aligned}
\frac{d\sigma_E^{V_l}(\theta_E, f_{1l}^E, s)}{d\Omega} &= \frac{d\sigma_E^{V_l}(\theta_E, f_{1l}^E, s' = s)}{d\Omega} + \frac{d\sigma_E^{V_l}(\theta_E, f_{1l}^E, s' = -s)}{d\Omega} = \\
&= \sigma_o^E (1 - \eta_E^2)^{-1} (1 + \eta_E^2 t g^2 \frac{\theta_E}{2}) (f_{1l}^E)^2 F_E^2(q_E^2),
\end{aligned} \tag{17}$$

$$\begin{aligned}
\frac{d\sigma_E^{V_l}(\theta_E, f_{1l}^E, < r_l^2 >_E, s)}{d\Omega} &= \frac{d\sigma_E^{V_l}(\theta_E, f_{1l}^E, < r_l^2 >_E, s' = s)}{d\Omega} + \\
&+ \frac{d\sigma_E^{V_l}(\theta_E, f_{1l}^E, < r_l^2 >_E, s' = -s)}{d\Omega} = \\
&= -\frac{2}{3} (m_l^E)^2 \gamma_E^{-1} \sigma_o^E (1 - \eta_E^2)^{-1} \times \\
&\times (1 + \eta_E^2 t g^2 \frac{\theta_E}{2}) f_{1l}^E < r_l^2 >_E F_E^2(q_E^2),
\end{aligned} \tag{18}$$

$$\begin{aligned}
\frac{d\sigma_E^{V_l}(\theta_E, < r_l^2 >_E, s)}{d\Omega} &= \frac{d\sigma_E^{V_l}(\theta_E, < r_l^2 >_E, s' = s)}{d\Omega} + \\
&+ \frac{d\sigma_E^{V_l}(\theta_E, < r_l^2 >_E, s' = -s)}{d\Omega} = \\
&= \frac{4}{9} (m_l^E)^4 \gamma_E^{-2} \sigma_o^E (1 - \eta_E^2)^{-1} \times \\
&\times (1 + \eta_E^2 t g^2 \frac{\theta_E}{2}) < r_l^4 >_E F_E^2(q_E^2),
\end{aligned} \tag{19}$$

$$\begin{aligned}
\frac{d\sigma_E^{V_l}(\theta_E, f_{2l}^E, s)}{d\Omega} &= \frac{d\sigma_E^{V_l}(\theta_E, f_{2l}^E, s' = -s)}{d\Omega} = \\
&= 4 (m_l^E)^2 \eta_E^{-2} \sigma_o^E (1 - \eta_E^2)^2 (f_{2l}^E)^2 F_E^2(q_E^2) t g^2 \frac{\theta_E}{2}.
\end{aligned} \tag{20}$$

The second term in (15) answers to the scattering going at the expense of the electroweak interference and must have the following structure:

$$\begin{aligned}
d\sigma_I^{V_l}(\theta_{EW}, s) &= d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, f_{1l}^I, s) + \\
&+ d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, < r_l^2 >_I, s),
\end{aligned} \tag{21}$$

$$\frac{d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, f_{1l}^I, s)}{d\Omega} = \frac{d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, f_{1l}^I, s' = s)}{d\Omega} +$$

$$\begin{aligned}
& + \frac{d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, f_{1l}^I, s' = -s)}{d\Omega} = \\
& = \rho_{EW} \sigma_o^{EW} (1 - \eta_{EW}^2)^{-1} \times \\
& \times (1 + \eta_{EW}^2 t g^2 \frac{\theta_{EW}}{2}) g_{V_l} f_{1l}^I F_I(q_{EW}^2),
\end{aligned} \tag{22}$$

$$\begin{aligned}
\frac{d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, < r_l^2 >_I, s)}{d\Omega} &= \frac{d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, < r_l^2 >_I, s' = s)}{d\Omega} + \\
& + \frac{d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, < r_l^2 >_I, s' = -s)}{d\Omega} = \\
& = -\frac{2}{3} (m_l^{EW})^2 \gamma_{EW}^{-1} \rho_{EW} \sigma_o^{EW} (1 - \eta_{EW}^2)^{-1} \times \\
& \times (1 + \eta_{EW}^2 t g^2 \frac{\theta_{EW}}{2}) g_{V_l} < r_l^2 >_I F_I(q_{EW}^2).
\end{aligned} \tag{23}$$

In the same way one can write the cross section of purely weak interaction of partially longitudinally polarized leptons with neutral currents

$$\begin{aligned}
\frac{d\sigma_W^{V_l}(\theta_W, g_{V_l}, s)}{d\Omega} &= \frac{d\sigma_W^{V_l}(\theta_W, g_{V_l}, s' = s)}{d\Omega} + \frac{d\sigma_W^{V_l}(\theta_W, g_{V_l}, s' = -s)}{d\Omega} = \\
& = \frac{G_F^2 (m_l^W)^2}{8\pi^2} \eta_W^{-2} (1 + \eta_W^2 t g^2 \frac{\theta_W}{2}) g_{V_l}^2 F_W^2(q_W^2) \cos^2 \frac{\theta_W}{2}.
\end{aligned} \tag{24}$$

By following the structure of formulas (15)-(24), it is easy to observe the negative signs of cross sections (18) and (23) which testify in favor of coexistence of the electric $f_{1l}(0)$ charge of lepton and its charge r_l radius. On the other hand, as follows from our earlier developments, between f_{1l} and f_{2l} there exists a connection [13, 20]. At the same time, lepton itself possesses simultaneously each of these three types of vector currents.

To establish their nature, it is desirable to reduce (9) after averaging the cross sections (10)-(12) over s and summing over s' to the form

$$\begin{aligned}
d\sigma_{E,W}^{V_l}(\theta_{E,W}) &= d\sigma_E^{V_l}(\theta_E) + \frac{1}{2} d\sigma_I^{V_l}(\theta_{EW}) + \\
& + \frac{1}{2} d\sigma_I^{V_l}(\theta_{EW}) + d\sigma_W^{V_l}(\theta_W).
\end{aligned} \tag{25}$$

As well as in (15), any term here describes a kind of the process and has the most diverse structure:

$$\begin{aligned}
d\sigma_E^{V_l}(\theta_E) &= d\sigma_E^{V_l}(\theta_E, f_{1l}^E) + \frac{1}{2}d\sigma_E^{V_l}(\theta_E, f_{1l}^E, < r_l^2 >_E) + \\
&\quad + \frac{1}{2}d\sigma_E^{V_l}(\theta_E, f_{1l}^E, < r_l^2 >_E) + \\
&\quad + d\sigma_E^{V_l}(\theta_E, < r_l^2 >_E) + d\sigma_E^{V_l}(\theta_E, f_{2l}^E),
\end{aligned} \tag{26}$$

$$d\sigma_I^{V_l}(\theta_{EW}) = d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, f_{1l}^I) + d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, < r_l^2 >_I), \tag{27}$$

$$d\sigma_W^{V_l}(\theta_W) = d\sigma_W^{V_l}(\theta_W, g_{V_l}). \tag{28}$$

Each cross section in them coincides with the corresponding components from solutions (16), (21), (24) and that, consequently, we have

$$d\sigma_E^{V_l}(\theta_E, f_{1l}^E) = d\sigma_E^{V_l}(\theta_E, f_{1l}^E, s), \tag{29}$$

$$d\sigma_E^{V_l}(\theta_E, f_{1l}^E, < r_l^2 >_E) = d\sigma_E^{V_l}(\theta_E, f_{1l}^E, < r_l^2 >_E, s), \tag{30}$$

$$d\sigma_E^{V_l}(\theta_E, < r_l^2 >_E) = d\sigma_E^{V_l}(\theta_E, < r_l^2 >_E, s), \tag{31}$$

$$d\sigma_E^{V_l}(\theta_E, f_{2l}^E) = d\sigma_E^{V_l}(\theta_E, f_{2l}^E, s), \tag{32}$$

$$d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, f_{1l}^I) = d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, f_{1l}^I, s), \tag{33}$$

$$d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, < r_l^2 >_I) = d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, < r_l^2 >_I, s), \tag{34}$$

$$d\sigma_W^{V_l}(\theta_W, g_{V_l}) = d\sigma_W^{V_l}(\theta_W, g_{V_l}, s). \tag{35}$$

Basing on (15) and (25), one can think that either an incoming lepton flux consists of longitudinal polarized particles or in it no fermions of any spin polarization. It is not difficult to see, however, that this is not quite so. The point is that the behavior of elementary particles of a definite helicity depends not only on their dynamical properties [13, 21] but also on the nature of medium [22] where they interact with matter. In other words, a fermion passing through the field of emission suffers a strong change in his spin direction. Thereby, the possibility of the presence of both longitudinally polarized and unpolarized leptons in fluxes of initial and final fermions is not excluded. The scattered particles can therefore constitute a partially ordered set of outgoing leptons.

Of course, to this class corresponds a set of cross sections. In our case, from (15) and (25), we are led to the following class:

$$d\sigma_{E,W}^{V_l} = \{d\sigma_{E,W}^{V_l}(\theta_{E,W}, s), \quad d\sigma_{E,W}^{V_l}(\theta_{E,W})\}. \quad (36)$$

Its elements describe a situation when any of cross sections (15) and (25) constitutes a kind of the structural subset:

$$\begin{aligned} d\sigma_{E,W}^{V_l}(\theta_{E,W}, s) = & \{d\sigma_E^{V_l}(\theta_E, f_{1l}^E, s), \quad \frac{1}{2}d\sigma_E^{V_l}(\theta_E, f_{1l}^E, < r_l^2 >_E, s), \\ & \frac{1}{2}d\sigma_E^{V_l}(\theta_E, f_{1l}^E, < r_l^2 >_E, s), \quad d\sigma_E^{V_l}(\theta_E, < r_l^2 >_E, s), \\ & d\sigma_E^{V_l}(\theta_E, f_{2l}^E, s), \quad \frac{1}{2}d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, f_{1l}^I, s), \\ & \frac{1}{2}d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, f_{1l}^I, s), \quad \frac{1}{2}d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, < r_l^2 >_I, s), \\ & \frac{1}{2}d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, < r_l^2 >_I, s), \quad d\sigma_W^{V_l}(\theta_W, g_{V_l}, s)\}, \end{aligned} \quad (37)$$

$$\begin{aligned} d\sigma_{E,W}^{V_l}(\theta_{E,W}) = & \{d\sigma_E^{V_l}(\theta_E, f_{1l}^E), \quad \frac{1}{2}d\sigma_E^{V_l}(\theta_E, f_{1l}^E, < r_l^2 >_E), \\ & \frac{1}{2}d\sigma_E^{V_l}(\theta_E, f_{1l}^E, < r_l^2 >_E), \quad d\sigma_E^{V_l}(\theta_E, < r_l^2 >_E), \\ & d\sigma_E^{V_l}(\theta_E, f_{2l}^E), \quad \frac{1}{2}d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, f_{1l}^I), \\ & \frac{1}{2}d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, f_{1l}^I), \quad \frac{1}{2}d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, < r_l^2 >_I), \\ & \frac{1}{2}d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, < r_l^2 >_I), \quad d\sigma_W^{V_l}(\theta_W, g_{V_l})\}. \end{aligned} \quad (38)$$

Both subclasses, according to (29)-(35), must be equal. However, a coincidence of cross sections (15) and (25) can take place only in the case where they answer to the different processes of formation of the same dileptons. Such a possibility is realized if all elements of sets (37) and (38) correspond to one of the four types of spin states of parafermions. This says in favor of the equality of the studied process cross section structural parts.

Another serious basis for such an universality is the existence in leptonic families of doublets or singlets of flavor symmetrical connection [17] of the left - and right-handed or the two left (right)-handed leptons of a definite

type. Similar dependence can appear as a consequence of the availability of the unified force responsible for the structure of dileptons. This unification convinces us once again that one must use the flavor symmetry as a theorem [23, 24] about the equality of cross sections of the interaction with field of emission of the structural components of all types of leptonic currents.

Thus, it follows that between the currents $f_{1l}^E, < r_l^2 >_E, f_{2l}^E, f_{1l}^I, < r_l^2 >_I$ and g_{V_l} there exist a hard connections, owing to which the interratio of each pair of elements in sets (37) and (38) is not different from unity and thereby allows to establish the forty two relations.

Together with the sizes of cross sections (29)-(35), the latter constitute a system of the twenty one most diverse equations. They are of course connected as well as with the functions of variables E_l^K, η_K, θ_K , and thus directly with the square of momentum transfer. Therefore, for establishing their explicit form, it should be chosen E_l^K so that to the case $q_K^2 \rightarrow 0$ corresponds a kind of scattering angle.

At the large energies ($E_l^K \gg m_l^K$) when $\eta_K \rightarrow 0, q_K^2 \rightarrow 0, \theta_K \rightarrow 0$, the exploring limits are reduced to the exact values [17, 25], because of which the structure of investigated relations becomes fully definite.

To elucidate their ideas, it is desirable to use five equations from the original system:

$$\frac{d\sigma_E^{V_l}(\theta_E, < r_l^2 >_E)}{d\sigma_E^{V_l}(\theta_E, f_{1l}^E)} = 1, \quad \frac{d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, f_{1l}^I)}{2d\sigma_E^{V_l}(\theta_E, f_{1l}^E)} = 1, \quad (39)$$

$$\frac{2d\sigma_W^{V_l}(\theta_W, g_{V_l})}{d\sigma_E^{V_l}(\theta_E, f_{1l}^E, < r_l^2 >_E)} = 1, \quad \frac{d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, < r_l^2 >_I)}{d\sigma_I^{V_l}(\theta_{EW}, g_{V_l}, f_{1l}^I)} = 1. \quad (40)$$

Uniting (39) and (40) with expressions of cross sections (29)-(35) and having in view the limits

$$\lim_{\eta_K \rightarrow 0, \theta_K \rightarrow 0} \frac{\eta_K^2}{(1 - \eta_K^2) \sin^2(\theta_K/2)} = -2,$$

$$\lim_{\eta_E \rightarrow 0, \theta_E \rightarrow 0} \frac{\eta_E^2 \sin^{-2}(\theta_E/2)}{(1 + \eta_E^2 t g^2(\theta_E/2)) \cos^2(\theta_E/2)} = 4,$$

one can found again from them that

$$\frac{1}{3} < r_l^2 >_E (m_l^E)^2 = \pm f_{1l}^E(0), \quad (41)$$

$$\frac{1}{6} < r_l^2 >_E m_l^E = \pm f_{2l}^E(0), \quad (42)$$

$$(f_{1l}^E(0))^2 = g_{V_l} \frac{G_F(m_l^E)^2}{2\pi\sqrt{2}\alpha} \frac{Z_W}{Z} f_{1l}^I(0), \quad (43)$$

$$\frac{1}{3} < r_l^2 >_E f_{1l}^E(0) = g_{V_l}^2 \frac{G_F^2(m_l^W)^2}{8\pi^2\alpha^2} \left(\frac{Z_W}{Z} \right)^2, \quad (44)$$

$$\frac{1}{3} < r_l^2 >_I (m_l^{EW})^2 = f_{1l}^I(0). \quad (45)$$

The solution of this system may be written as

$$f_{1l}^E(0) = g_{V_l} \frac{G_F m_l^E m_l^W}{2\pi\sqrt{2}\alpha} Z_W^*, \quad (46)$$

$$f_{2l}^E(0) = g_{V_l} \frac{G_F m_l^W}{4\pi\sqrt{2}\alpha} Z_W^*, \quad (47)$$

$$f_{1l}^I(0) = g_{V_l} \frac{G_F(m_l^W)^2}{2\pi\sqrt{2}\alpha} Z_W^*, \quad (48)$$

$$< r_l^2 >_E = \pm g_{V_l} \frac{3G_F}{2\pi\sqrt{2}\alpha} \frac{m_l^W}{m_l^E} Z_W^*, \quad (49)$$

$$< r_l^2 >_I = g_{V_l} \frac{3G_F}{2\pi\sqrt{2}\alpha} \left(\frac{m_l^W}{m_l^{EW}} \right)^2 Z_W^*. \quad (50)$$

The presence of $Z_W^* = Z_W/Z$ in currents (46)-(50) simultaneously includes in the discussion as well as the possible change of their self values in the target nucleus isotopic structure dependence.

To exclude this influence, we must at first choose a nucleus with an equal number of neutrons and protons. At the same time, one should keep in mind that $f_{1l}(0) = f_{1l}^E(0) + f_{1l}^I(0)$, $f_{2l}(0) = f_{2l}^E(0)$, $< r_l^2 > = < r_l^2 >_E + < r_l^2 >_I$.

Using in them (46)-(50) at $N = Z$, we establish here an explicit mass structure dependence of leptonic currents of the vector nature

$$f_{1l}(0) = -g_{V_l} \frac{G_F m_l^W m_l^{EW}}{\pi\sqrt{2}\alpha} \sin^2 \theta_W, \quad (51)$$

$$f_{2l}(0) = -g_{V_l} \frac{G_F m_l^W}{2\pi\sqrt{2}\alpha} \sin^2 \theta_W, \quad (52)$$

$$\langle r_l^2 \rangle = -g_{V_l} \frac{3G_F}{2\pi\sqrt{2}\alpha} \frac{m_l^W}{m_l^E} \left(3 - \frac{(m_l^E)^2 + (m_l^W)^2}{(m_l^{EW})^2} \right) \sin^2 \theta_W. \quad (53)$$

Taking into account (1) and all what the standard electroweak theory says about fermions, it is not difficult to express (51)-(53) in a latent united form

$$f_{1l}(0) = e_l, \quad f_{2l}(0) = \mu_l = \frac{e_l}{2m_l}, \quad (54)$$

$$\langle r_l^2 \rangle = \frac{3\mu_l}{m_l^E} \left(3 - \frac{(m_l^E)^2 + (m_l^W)^2}{m_l^2} \right), \quad (55)$$

in which

$$e_l = -g_{V_l} \frac{G_F m_l^W m_l}{\pi\sqrt{2}\alpha} \sin^2 \theta_W \quad (56)$$

corresponds to the lepton renormalized charge.

So, we have learned that f_{2l} coincides with a Dirac value of magnetic moment. Insofar as its anomalous part [27] is concerned, analogously to how f_{1l}^I and $\langle r_l^2 \rangle_I$ components of charge and charged radius arise in electroweakly united processes with these currents, it can appear only in the case when the interaction originates at the expense of exchange by the two photons.

If we suppose [28] that $\sin^2 \theta_W = 0.231$, jointly with well known laboratory facts [29], the solution (56) predicts the size of the lepton weak masses $m_e^W = 9.92 \cdot 10^{-2}$ eV, $m_\mu^W = 4.8 \cdot 10^{-4}$ eV, $m_\tau^W = 2.85 \cdot 10^{-5}$ eV.

This presentation is based logically on the equality of the absolute values of charges of electron and other types of leptons, because of which the relation (56) suggests one more highly important connection

$$m_l^W m_l = \text{const.} \quad (57)$$

Thus, at the availability of rest mass and its structure, all leptons regardless of the difference in masses, must have the same charge with his radius as well as an equal magnetic moment. It is not a wonder therefore that if (57) holds, then, for example, leptons universally interact not only with γ or Z^0 but also with any of gauge bosons. Of course, such a regularity reflects the characteristic features of the structure of mass, charge and thereby opens of principle possibility for establishing the nature of an universality of all types of interactions of particles and fields.

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